ELECTROCARDIOGRAPHIC CHANGES IN WOMEN WITH IRON DEFICIENCY ANEMIA: ASSOCIATION WITH HEMOGLOBIN LEVELS

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Abstract. *Iron deficiency anemia (IDA) is a common condition among women and may lead to cardiovascular dysfunction. This study aimed to evaluate electrocardiographic (ECG) changes in women with IDA and to assess their association with hemoglobin levels. A total of 60 women with IDA underwent laboratory assessment and standard 12-lead ECG recording. Patients were stratified according to anemia severity. ECG abnormalities were identified in 68.3% of cases and increased with decreasing hemoglobin levels. Sinus tachycardia, QTc prolongation, and ST-T changes were significantly more frequent in moderate and severe anemia. Hemoglobin levels showed a significant inverse correlation with heart rate and QTc duration. ECG assessment may be useful for early detection of cardiac involvement in women with iron deficiency anemia.*

Keywords: *Iron deficiency anemia; electrocardiography; hemoglobin; QTc interval; women; cardiovascular changes.*

Introduction. Iron deficiency anemia (IDA) remains one of the most prevalent hematological disorders among women of reproductive age worldwide. According to recent epidemiological data, IDA affects up to one third of women, leading not only to reduced quality of life but also to systemic metabolic and cardiovascular consequences.

Iron plays a crucial role in oxygen transport, mitochondrial energy metabolism, and myocardial function [1, 2]. Chronic iron deficiency results in tissue hypoxia, compensatory hyperdynamic circulation, and increased cardiac workload, which may be reflected in electrocardiographic (ECG) alterations. Despite the known pathophysiological links between anemia and cardiovascular dysfunction, ECG manifestations of IDA in women remain insufficiently characterized, particularly in relation to anemia severity.

Early detection of cardiac electrical changes may have important clinical implications for risk stratification and prevention of cardiovascular complications. Therefore, evaluating ECG parameters in women with IDA and their association with hemoglobin levels represents a relevant and timely research focus [3]. The aim of this study was to assess ECG changes in women with iron deficiency anemia and to determine the relationship between ECG alterations and hemoglobin concentration.

Materials and methods. This observational study was conducted at the "Doctor Magnus" clinic in Andijan city. A total of 60 women diagnosed with iron deficiency anemia were included in the study. Diagnosis of IDA was based on clinical assessment and laboratory confirmation of reduced hemoglobin and iron metabolism parameters.

Participants underwent comprehensive clinical and laboratory evaluation, including measurement of hemoglobin, erythrocyte count, mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), serum ferritin, and serum iron levels.

Based on hemoglobin concentration, patients were stratified into groups corresponding to mild, moderate, and severe anemia. All participants underwent standard 12-lead electrocardiography at rest. ECG parameters analyzed included heart rate, rhythm, PR interval, QRS duration, QT and corrected QT (QTc) intervals, ST-segment deviations, and T-wave morphology.

Statistical analysis was performed using appropriate parametric and non-parametric methods. Intergroup comparisons were conducted to assess differences in ECG findings across anemia severity levels, and correlation analysis was used to evaluate associations between hemoglobin levels and ECG parameters.

Results. The study included 60 women with iron deficiency anemia: mild (36.7%), moderate (40.0%), and severe anemia (23.3%). Mean hemoglobin levels were 109.3 ± 5.4 g/L, 86.7 ± 7.1 g/L, and 62.4 ± 6.2 g/L, respectively ($p < 0.001$). Serum ferritin levels decreased significantly with anemia severity (18.6 ± 4.3; 9.8 ± 3.1; 4.2 ± 1.5 ng/mL; $p < 0.001$). ECG abnormalities were detected in 68.3% of patients.

Mean heart rate increased from 78.4 ± 6.9 bpm in mild anemia to 91.6 ± 8.2 bpm in moderate and 104.3 ± 9.5 bpm in severe anemia ($p < 0.001$). Sinus tachycardia was observed in 9.1%, 45.8%, and 78.6% of patients, respectively. QTc prolongation (>440 ms) was found in 13.6% of patients with mild anemia, 37.5% with moderate anemia, and 64.3% with severe anemia ($p = 0.002$). Mean QTc values were 421.5 ± 18.6 ms, 438.7 ± 21.4 ms, and 462.9 ± 24.1 ms. ST-T abnormalities were more frequent in severe anemia (57.1%) compared to moderate (29.2%) and mild anemia (4.5%). Hemoglobin levels showed significant inverse correlations with heart rate ($r = –0.62$, $p < 0.001$) and QTc duration ($r = –0.58$, $p < 0.001$).

Discussion. The results of this study confirm that iron deficiency anemia in women is associated with clinically meaningful ECG changes, particularly in cases of moderate and severe anemia. Sinus tachycardia and repolarization abnormalities appear to be adaptive responses to chronic hypoxia and reduced oxygen delivery. Prolongation of the QTc interval may reflect altered myocardial ion channel function and increased susceptibility to arrhythmias.

The observed correlation between hemoglobin levels and ECG parameters highlights the importance of anemia severity as a determinant of cardiovascular involvement. These findings are consistent with recent studies emphasizing the role of iron deficiency in cardiac dysfunction, even in the absence of overt structural heart disease.

Early identification of ECG abnormalities in women with IDA may allow timely correction of iron deficiency and prevention of potential cardiovascular complications. Routine ECG assessment could therefore be considered as part of the comprehensive evaluation of patients with moderate to severe iron deficiency anemia.

Conclusion. Iron deficiency anemia in women is associated with significant electrocardiographic changes that correlate with the degree of hemoglobin reduction. The severity of anemia plays a key role in the development of cardiac electrical disturbances.

ECG assessment may serve as a useful non-invasive tool for early detection of cardiovascular involvement in women with iron deficiency anemia and may contribute to improved clinical management and prevention strategies.

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